

CLAIMS

1. A method of producing thrust in an object without ejection of propellant; the method comprising the following steps:

a) providing a force transducer having a mechanical resonance frequency and having a material core responsive to an applied time-varying electromagnetic field by storing energy in said core as a result of material polarization which induces transient mass fluctuations in said core in accordance with said time-varying electromagnetic field;

b) applying a first time-varying electromagnetic signal to said force transducer to induce said transient mass fluctuations;

c) applying a second time-varying electromagnetic signal to said force transducer at said mechanical resonance frequency to excite a mechanical oscillation in said transducer; and

d) controlling the relative amplitudes and phase of said first and second time-varying electromagnetic signals to induce a thrust in said transducer.

2. The method recited in claim 1 wherein said first time-varying electromagnetic signal has a frequency which is one-half the frequency of said second time-varying electromagnetic signal.

3. The method recited in claim 1 wherein each of said first and second time-varying electromagnetic signals comprises an AC electrical signal.

4. The method recited in claim 3 wherein step d) is carried out by the following steps:

- e) generating an electrical signal;
- f) connecting said signal to a frequency doubler and to a phase shifter;
- g) combining the outputs of said frequency doubler and said phase shifter; and
- h) applying said combined outputs to at least one amplifier.

5. The method recited in claim 1 further comprising the step of connecting said force transducer by a connecting mechanism to an object to be subjected to said thrust and wherein said mechanical resonance frequency is the mechanical resonance frequency of the combination of the force transducer and the connecting mechanism.

6. The method recited in claim 5 wherein said connecting mechanism comprises a rod having opposed ends and wherein said rod is affixed to the force transducer at a first end and is affixed to the object at a second end.

7. The method recited in claim-1 further comprising the step of phase-locking the first and second time-varying electromagnetic signals to one another with a selected phase difference between their respective waveforms.

8. A method of producing thrust in an object without ejection of propellant; the method comprising the following steps:

a) providing a plurality of force transducers having a mechanical resonance frequency and having a material core responsive to an applied time-varying electromagnetic field by storing energy in said core as a result of material polarization, which induces transient mass fluctuations in said core in accordance with said time-varying electromagnetic field;

b) applying a first time-varying electromagnetic signal to said plurality of force transducers to induce said transient mass fluctuations;

c) applying a second time-varying electromagnetic signal to said plurality of force transducers at said mechanical resonance frequency to excite a mechanical oscillation in said transducers; and

d) controlling the relative amplitudes and phase of said first and second time-varying electromagnetic signals to induce a thrust in said transducers.

9. The method recited in claim 8 wherein said first time-varying electromagnetic signal has a frequency which is one-half the frequency of said second time-varying electromagnetic signal.

10. The method recited in claim 8 wherein each of said first and second time-varying electromagnetic signals comprises an AC electrical signal.

11. The method recited in claim 10 wherein step d) is carried out by the following steps:

- e) generating an electrical signal;
- f) connecting said signal to a frequency doubler and to a phase shifter;
- g) combining the outputs of said frequency doubler and said phase shifter; and
- h) applying said combined outputs to at least one amplifier.

12. The method recited in claim 8 further comprising the step of connecting said force transducers by a connecting mechanism to an object to be subjected to said thrust and wherein said mechanical resonance frequency is the mechanical resonance frequency of the combination of the force transducers and the connecting mechanism.

13. The method recited in claim 12 wherein said connecting mechanism comprises a rod having opposed ends and wherein respective ones of said plurality of force transducers are affixed to said opposed ends of said rod and said object is affixed to said rod between said opposed ends.

14. The method recited in claim 13 further comprising the step of controlling the respective phases of said first and second time-varying electromagnetic signals so that mass fluctuations in said respective ones of said plurality of force transducers are selected to produce a net force in said object.

15. An apparatus for producing thrust in an object to which the apparatus is connected, the apparatus comprising:

a force transducer having a mechanical resonance and having a material core responsive to an applied time-varying electromagnetic field by storing energy in said core as a result of material polarization which induces transient mass fluctuations in said core in accordance with said time-varying electromagnetic field;

means for applying a first time-varying electromagnetic signal to said force transducer to induce said transient mass fluctuations;

Claim 15. Continued

means for applying a second time-varying electromagnetic signal to said force
10 transducer at said mechanical resonance frequency to excite a mechanical oscillation
in said transducer; and

means for controlling the relative amplitudes and phase of said first and second
time-varying electromagnetic signals to induce thrust in said transducer.

16. The apparatus recited in claim 15 wherein the frequency of said first time-
varying electromagnetic signal is one-half the frequency of said second time-varying
electromagnetic signal.

17. The apparatus recited in claim 15 wherein each of said first and second time-
varying electromagnetic signals comprises an AC electrical signal.

18. The apparatus recited in claim 15 wherein said means for controlling comprises
an electrical signal generator the output of which is applied both to a frequency doubler
and a phase shifter the respective outputs of which are combined and amplified in a
power amplifier.

19. An apparatus for producing thrust in an object to which the apparatus is connected, the apparatus comprising:

a plurality of force transducers having a mechanical resonance and having a material core responsive to an applied time-varying electromagnetic field by storing energy in said core as a result of material polarization which induces transient mass fluctuations in said core in accordance with said time-varying electromagnetic field;

means for applying a first time-varying electromagnetic signal to said plurality of force transducers to induce said transient mass fluctuations;

means for applying a second time-varying electromagnetic signal to said plurality of force transducers at said mechanical resonance frequency to excite a mechanical oscillation in said transducers; and

means for controlling the relative amplitudes and phase of said first and second time-varying electromagnetic signals to induce thrust in said transducers.

20. The apparatus recited in claim 19 wherein said force transducers are affixed at opposite ends of a rod and said object is connected to said rod between said ends and wherein said means for controlling adjusts the respective phases of said first and second time-varying electromagnetic signals so that mass fluctuations in said respective force transducers are selected to produce a net force in said object.

34